Distr:
LIMITED

ECA/NRD/WCA/3 A
17 January 1985

Original: ENGLISH

ECONOMIC COMMISSION FOR AFRICA

The Second Regional Conference on the Development and Utilization of Mineral Resources in Africa

Lusaka, Zambia, 4-14 March 1985

A PAPER ON

THE MANUFACTURING POTENTIAL OF COPPER-BASED PRODUCTS IN THE AFRICAN REGION - PRELIMINARY REVIEW

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THE MANUFACTURING POTENTIAL OF COPPER-BASED PRODUCTS IN THE AFRICAN REGION - A PRELIMINARY REVIEW

1. INTRODUCTION

Two of the World's major copper-producing nations, Zambia and Zaire are located within the Central African region. Between them these countries account for approximately 20 per cent of the Non-Communist World's production of copper which for 1983 amounted to 6.18 million tonnes. The Central African region is also a major producer of a variety of other metals, notably, cobalt, zinc, lead and cadmium. Despite the fact that the region has been associated with base metal mining activity for over fifty years there has been no significant developments of secondary industries based on these metals. This paper presents a preliminary review of some of the factors that have thwarted the emergence of a metals industry in Africa, excluding the Republic of South Africa. An overview of world-wide production and consumption patterns of copper-based products is presented followed by an outline of copper-based products in Africa and comments made on resource implications.

2. CONSUMPTION PATTERNS OF COPPER-BASED PRODUCTS

According to available statistics virtually all the refined copper produced is consumed outside Africa. For 1983, the total world consumption of refined copper was about 9.1 million metric tonnes, of which about 2.3 million metric tonnes was consumed by the socialist countries and 6.8 million metric tonnes by the non-socialist countries. A rough breakdown of consumption figures for the non-socialist countries is shown below.

West Europe, USA, Canada and Japan	- 5.79 million tonnes
Argentina, Brazil, Chile and Mexico	- 0.29 million tonnes
Australia	- 0.11 million tonnes
Africa (excluding RSA)	- 0.02 million tonnes
RSA	- 0.07 million tonnes
Others	- 0.49 million tonnes
Total	- 6.77

World (non-socialist) scrap recovery amounted to 3.72 million tonnes of which Africa (excluding RSA) accounted for 0.004 million tonnes. Western Europe, USA, Canada and Japan account for 85 per cent of the total Western world consumption. Consumption in Western Europe in percentage terms and in type and end-uses is shown below.

TYPE	CONSUMPTION[xx]
Copper wire	50%
Copper alloy rods	23%
Copper tube	14%
Rolled copper alloys	13%
	100

END-USE SECTORS (1975)[xxx]	
Electrical Engineering	54.3%
Building and Construction	15.5%
Transportation	10.7%
Consumer products	5.5%

There are many factors affecting the demand for copper. The principal ones are:

(i) Price of copper and its competing materials, chiefly plastics (PVC), aluminium, steel etc.

(ii) Impact of other relatively new competing materials such as optical fibres in the communications industry.

(iii) Impact of increasing energy costs.

(iv) Technical development and new applications.

Factor (i) is especially serious in the electrical engineering, building and construction sectors. Aluminium has long been a serious competing material for its light weight and cheaper price in the electrical industry. Miniaturization of electrical/electronic components is also a factor affecting copper consumption. Another serious competitor is fibre optics for the communications industry.

In building and construction, plastics and steel are the main competing materials. In applications where copper properties are not essential as in some plumber's fittings such as waste systems, plastics have taken business from copper.

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xx I.H. Pahl, Proc International Conference on Present and Future markets for copper. Paper 2, Page 5, October 1979.

xxx M.H. Davies, Proc. International Conference on Present and Future Markets for copper. Paper 8 (Table) October 1979.

On the other hand Research and Development has contributed to the growth of the market for copper by developing new uses or through substitution of non-copper based materials. The latter is important from the point of view of the African region as substitution of traditional materials with copper based ones on the basis of regional economics could open a significant market.

3. THE NATURE OF COPPER-BASED PRODUCTS

Copper-based products are made from plain copper or copper alloys. The plain copper used is made to very stringent purity specifications mainly to ensure high electrical conductivity levels. Copper alloyed with zinc forms a range of alloys known as the brasses which are the most widely used of the copper alloys. Normal commercial brasses containing upward of 60 per cent copper are obtainable in various forms, wire, tubes, sheets, rods, castings, pressings, etc. Alloyed with elements such as aluminium, tin, manganese and iron, alloy brasses with special properties relating to strength and corrosion resistance are obtained and are used in such applications as valve bodies, pump parts, condenser tubes and bolts and nuts. Certain alloys of copper and zinc with small quantities of lead up to about 3.5 per cent constitute the free-cutting brasses which have extremely high machinabilities and are extensively used in the extruded form as feedstock into automatic machine tools for rapid machining of complex parts.

True bronzes are alloys of copper and tin up to normally about 10 per cent tin. Alloys of manganese and copper, and aluminium and copper are known as manganese bronzes and aluminium bronzes respectively. Phosphor bronzes are tin bronzes with phosphorus additions of around 1 per cent. Tin bronzes containing zinc are known as gunmetals.

The bronzes fall into two main classes, the wrought alloys used in the form of wire and strip chiefly for springs, gauze and such applications, and the cast alloys used as bearings and for general engineering purposes. The latter includes such applications as valves and pump parts. A special application of aluminium bronze is non-sparking tools.

Electrical Engineering

Power transmission cables and wire

Telecommunication cables

Conductors in electrical machinery

Electrical contacts

Welding electrodes

Contact springs

Resistance wire

Thermocouple wire

Magnetic alloys

Chemical Engineering

Stills, vats, kettles, and autoclaves

pipes and fittings for corrosive liquids

Pickling containers, chains and hooks

Heat exchanger equipment such as condenser tubes

Corrosion resistant gauge

Valve and pump parts

Marine Engineering

Propellers

Rudders

Pipes and fittings

Valve and pump parts

Nuts and bolts

Chains and hooks

Decorative trim

Sheathing for small craft

Building and Plumbing

Roofing

Damp-proof courses

Gutters

Storage tanks and cylinders

Piping

Pipe unions, taps and valves

Boilers

Radiators

Decorative and Household

Architectural and decorative metalwork

Railings

Jewellery and other personal effects

Coins

Jugs, kettles, cans

Pins, fasteners, chains, hooks

Bells

Cutlery

A small but growing area of copper consumption is in the agricultural sector for the manufacture of fertilisers, insecticides and fungicides. Manufacture of these products require the establishment of chemical industries which have not been considered in this paper.

Copper and copper alloys are mostly processed into wire, plate, sheet, strip, tube, rod, sections or castings, from which form the final products are manufactured.

About half the copper produced in the world is used as electrical conductors and around four-fifths of this is in the form of wire. Cast copper wirebars weighing about 100 kg and having a cross-section of about 10 cm by 10 cm are heated and then rolled in a series of dies to produce wire with diametres ranging down to about a twenty-fifth of a millimetre. The wire may be used as single conductors or it may be stranded in machines to form wire rope which is then insulated and woven again into patterns to give the familiar insulated cable.

Recently the tendency has been to combine the casting and rolling into a single stage with a continuous casting and integrated rolling mill producing continuous wire-rod. This eliminates the heating stage for rolling and gives rise to a faster rate of production.

The manufacture of brass, bronze and other copper alloy wire is similar, except that brass wire rod is largely made by extrusion, a process whereby a heated billet is forced through a small die under the pressure of a hydraulic ram.

Plates, sheet and strip are obtained by a series of rolling operations. Other than the initial stages of plate rolling, the rolling is carried out in the cold to effect the necessary surface finish and to impart the required mechanical properties. The control of surface texture, dimension and edge conditions in sheet and strip manufacture particularly, call for highly controlled equipment. Final heating is necessary if soft sheet and strip are required, example for deep drawing or pressing into products.

Although a few copper and copper alloy tubes are made by brazing or welding sheet, the vast majority of tubes are seamles. To produce seamless tube the metal is cast in the form of cylindrical billet which is heated and cored by a mandrel by either rolling or extruding the billet over it. Great control is necessary to ensure the formation of a defect-free tube.

Rods and sections are produced by rolling or extrusion and a large variety of shapes are possible by changing the rolls or extrusion dies.

All of the above processes involve large capital expenditure and many ancillary services. Casting, on the other hand, can be carried out on a small scale. However, to produce items of controlled composition and properties by casting, a reasonable capital outlay is necessary.

5. POTENTIAL FOR MANUFACTURE AND UTILISATION OF COPPER-BASED PRODUCTS IN AFRICA

From what has been stated above it is evident industries for the manufacture of copper-based products are highly capital intensive which perhaps explains the fact that they have thus far been confined to industrialized countries. Technically, however, there is no reason why most copper based products cannot be made in the Africa region. For example, in Zambia, Metal Fabricators of Zambia Ltd (ZAMEFA) presently produce about 2000 tonnes per annum consisting of 126 types of extruded and drawn copper based products, chiefly copper cables for the domestic market. Occasionally, exports orders are secured. The semis produced are expensive due to the small-scale of manufacture, but the finished products are competitive when compared to international prices. The capacity of the continuous casting plant for copper is 6000 tonnes per annum but with a small investment this can be increased to 9000 tonnes per annum.

A number of non-ferrous foundries in Zambia produce cast copper based products, a typical example being copper-lead, copper-tin and copper-aluminium bearings for heavy machinery. Again the domestic market predominates and export is rare, mainly due to lack of marketing contacts. One foundry (Non-Ferrous Metal Works (Zambia) Ltd has received K1.4 million from the Development Bank of Zambia to expand its activities from the present sand casting and centrifugal casting to include stamping, die casting and controlled induction melting, the latter being envisaged mainly for cast iron. Once expanded this company could produce a total of around 1000 tonnes per annum of cast aluminium, brass, bronze, copper, lead alloys and whitemetal using locally available raw materials.

Since there is no basic technical barrier to the establishment of copper based industries in Africa, the potential for manufacture must depend on economic factors which in turn depend heavily on the available market. The available market consists of the regional market, which is controllable through agreement, and the external market which must be competed for:

Competing with established manufacturing organisations in the industrialised countries is difficult for the following reasons:

(i) The large capital investment to establish industries and the need to recover this in a reasonable period of time.

(ii) The small size of the home market to support the industry, particularly in view of the variety of products and sizes involved.

(iii) The foreign exchange requirements for the importation of machinery, spares and technical know-how to meet international standards.

(iv) The cost of transport since packaging costs and transport rates are both higher for semis and finished products compared to the raw material.

(v) The tariff barriers in the industrialised countries against the import of semis and finished products.

(vi) The overall reluctance of the industrialised nations to lose their manufacturing capacity. This may manifest itself as a cut-back on investment in copper mining development from those countries.

There are certain products for which favourable conditions exist. For example, free cutting brass is made of copper, zinc and lead, all metals produced locally. Large quantities of free cutting brass semis made by extrusion are used as feedstock into automatic machine tools in the industrialised countries. Thus, export of free cutting brass semis from the region is a possibility worth examining. However, though the external market must be kept in view during planning, the establishment of copper based industries in the region will depend critically on the regional market for the reasons outlined earlier.

Presently no information on the market for copper based products in Africa is readily available for examination, not even the present total consumption of copper in all forms as a continent. Consequently, an exact analysis of industrialisation requirements is impossible at this stage and so this paper has endeavoured to indicate broadly the areas in which data should be collected and development effort directed.

Clearly the first and most important step is a market survey in the region to determine the copper based product mix and quantities required. This should include those copper based products which would be substitutes for other types on the basis of regional economics. It is only from this data that it will be possible to estimate the component of the market demand that could be met economically by expansion of existing manufacturing facilities or by establishment of new ones. In doing so it is important to take into consideration the continuity of the market demand as previous experience has shown that sometimes national requirements can fluctuate to an extent which a manufacturer cannot absorb; this is particularly so of large projects funded by aid schemes.

The consumption of refined copper as given by the World Metals Statistics for Africa (excluding the Republic of South Africa) amounts to only 21,300 tonnes. This figure reflects the refined copper used as an input in the manufacture of copper based products. What is of greater relevance for this study is an estimate of the level of consumption of copper based products in the African region.

For the latter purpose we have attempted to estimate the magnitude of the regional market for copper based products based on Zambian figures. This must be regarded as a gross approximation only. The total consumption of copper in all forms in Zambia approximates 2200 tonnes per annum. The population of Zambia is roughly 5.80 million which puts the present per capita consumption of copper based-products in the country at 0.38 kg. Zambia is probably more industrialised than the average country in Africa so that using this per capita figure as an average would give upper limit figures. Some compensation will be effected by the fact that a technical study can reveal areas in which copper-based products could be economically substituted for others. Using 0.38 kg as an average per capita consumption, the consumption and market distribution of copper based products in Africa is as follows:

Region	Population (millions)	Estimated Total Consumption of copper Based products (tonnes/) annum	Estimated Demand in the electrical sector (tonnes)/ annum	Estimated Demand in the foundry sector (tonnes/ annum	Estimated Demand for other miscellaneous items (tonnes/ annum
East and Central Africa	125.90	48,000	29,000	5,000	14,000
Southern Africa (excluding RSA)	35.5[illegible]	14,000	8,000	1,500	4,500
West Africa	128.9[illegible]	49,000	30,000	5,000	14,000
Sahara and Sahel	2[illegible].45	10,000	[illegible],000	2,000	2,000
North Africa	109.04	41,000	25,000	4,000	12,000
Equatorial Africa	10.89	4,000	2,500	400	1,100
Ocean Islands	15.52	6,000	3,500	[illegible]00	1,900
TOTAL FOR AFRICA	452.32	172,000	104,000	18,500	49,500

Given the nature and stage of development of countries in Africa, it is likely that the greatest demand, amounting to about 60 per cent of the total demand, arises from the electrical sector for extruded and drawn copper products mainly as power transmission cables and wire, telecommunication cables and conductors for electrical distribution and machinery. . The estimated demand column for the electrical sector has been prepared on this basis.

The next in terms of level of demand for a single type would be mechanical engineering components cast from copper alloys. This is estimated at 10 per cent of the total demand, and the column on the foundry sector was computed accordingly. A significant proportion of these components would be spares such as bearing bushes for imported machinery and equipment so that the need to deal with licensing agreements would arise.

The balance items would form a large miscellany of copper alloy products used in the region in such areas as domestic appliances and construction for which the economics of scale militate against local manufacture. Regional standardisation would be the most effective means of meeting this situation.

6. RESOURCE IMPLICATIONS

The additional resources necessary to develop and support a local manufacturing programme to meet the market demand can only be estimated with a knowledge of the existing facilities for manufacturing copper-based products, their distribution and capability as well as a knowledge of the ancillary units and services available. Such data are not available and must be collected before any meaningful comments can be made on this topic. However, it is fairly evident that, besides the normal commercial organisations that may be needed, the resource implications would include:

(i) The establishment of a regional marketing authority for copper based products to carry out the initial market survey and subsequently provide the necessary marketing contacts and information in Africa.

This body could also conduct the survey among the African countries to determine the details of the existing industries producing copper based products, their expansion plans and the availability of supporting industries and services.

(ii) The establishment of a regional standardisation authority for copper based products with the ultimate objective of effecting a greater degree of regional manufacture through rationalisation and standardisation, but also assisting in the maintenance of product quality by provision of the necessary standard specifications.

(iii) A regional physical metallurgy centre to provide the necessary testing and consultancy services which are required to develop appropriate routes, overcome manufacturing equipment, and maintain a specialist quality assurance back-up. Sustained acceptable product quality is an essential ingredient of an economically successful local manufacturing programme.

Zambia Consolidated Copper Mines Limited has technical services organisation which provides comprehensive testing and consultancy

services to manufacturing units within the company and outside, and has considerable expertise and experience in import substitution work. It would be more economical to expand such an organisation to become a regional centre for this type of work.

(iv) Manufacturing industries to make extruded, drawn, pressed and cast copper based products to increase existing installed capacity to levels sufficient to meet the estimated demand.

As an example, in East and Central Africa, to satisfy the demand in the electrical sector, at least two more manufacturing organisations of the type and size of ZAMEFA Ltd in Zambia all working at full capacity are required.

In summary, considerable potential does appear to exist in the African region for the manufacture and utilisation of copper-based products. However, we are at a very preliminary stage in the exploitation of this potential for the socio-economic development of the region as even the basic data necessary for the planning of industrial expansion in this sector are not readily available. Thus, it is necessary that a regional market survey be carried out for copper based products together with a determination of the existing regional facilities for manufacturing such products, their distribution and capability as well as the ancillary units and services available.

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